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Vol V

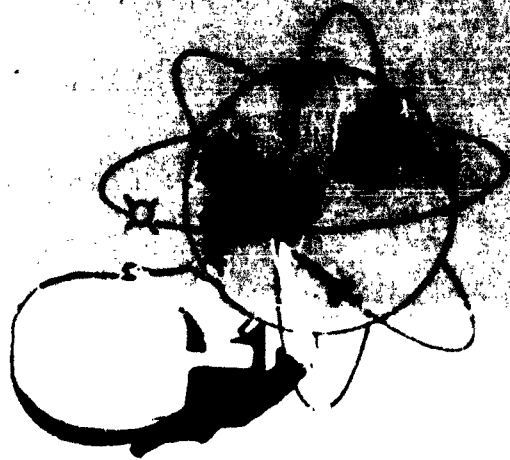
## PERT EACH

(PERT Network Development and Computer Processing, Volume V)  
TECHNICAL DOCUMENTARY REPORT NO. ESD-TDR-63-198

OPERATIONAL APPLICATIONS LABORATORY  
DEPUTY FOR TECHNOLOGY  
ELECTRONIC SYSTEMS DIVISION  
AIR FORCE SYSTEMS COMMAND  
F. G. Hunscom Fld., Bedford, Mass

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(Prepared under contract AF19(628)-365 by the Equipment Division, Raytheon Co. Waltham, Mass.)

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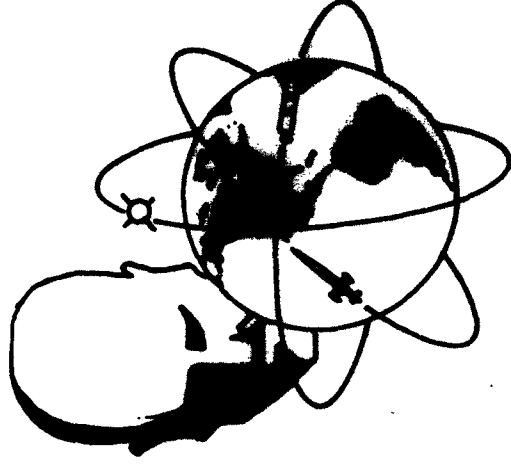
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L. G. Hanscom Fld., Bedford, Mass



(Prepared under contract AF19(628)-365 by the Equipment Division, Raytheon Co. Waltham, Mass)

**NOTE: Instructions for this volume  
and all other volumes are to  
be found in Volume I.**

ESD-TDR-63-198

PERTeach

ABSTRACT

This self-instructional course teaches the basic concepts and techniques of PERT (Program Evaluation Review Technique.) The course consists of six volumes and is intended for use by Air Force managers. Presented in programmed-instruction format, the course allows the student to proceed at his own pace and to learn without the aid of an instructor.

PUBLICATION REVIEW AND APPROVAL

This Technical Documentary Report has been reviewed and is approved.

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## VOLUME V

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**PERTeach**  
**Volume V**  
**CHAPTER 1**  
**The Input Form**

Look again at Panel J, in Volume VI, workbook. Since you have coded all the events on the network (see Panel N), the next step in data processing is to transfer the input information to the \_\_\_\_\_.

## Input Form

Panel K is an exhibit of the Input Form, otherwise titled the "\_\_\_\_\_  
Report." The columns that can be completed directly from the network  
(Panel N) include the Beginning Event Number. List the other columns that  
can be completed directly from Panel N.

PERT	
Ending Event Number	
Optimistic Time	Time Interval Estimates
Most Likely Time	
Pessimistic Time	
Event Title	

Columns F and H on the PERT Report are both labeled "\_\_\_\_\_".  
This word refers to the letter of the alphabet that appears after the 9-digit event coding. Describe in your own words what this letter signifies.

## Chapter 5

### Summary

Interrelating the events in different networks of the same over-all program, in order to show the impact of events upon each other, is made possible by the network integration technique. The first and major step in this technique is the location of interface events - those common to each network.

Although individual network plans may be satisfactory, once they are integrated, scheduling of one network may affect the others so much that new plans are made necessary.

This the final page of PERT Network Development and Computer Processing, Volume V of PERTeach. You have now completed the course. We hope you enjoyed taking it and that the knowledge you have gained will be useful to you.

## Shredout

level of management interested in an event

---

The varying levels of management, because of their differing interests, will be given different shredouts. A shredout will often include certain events (and their accompanying data) while excluding others. The distribution of selected information to management is the function of the \_\_\_\_\_ code.

TEST NO. 5

Circle the letter identifying the phrase which appears to be most nearly correct.

1. The Integration Technique allows you to evaluate
  - a) the impact of events in different networks upon each other.
  - b) the relationships between events in the same network.
  - c) the impact of new facts on the progress of the critical path.
  - d) the relationships between the old critical path and the new one.
2. An Interface Event
  - a) connects one activity to another.
  - b) connects a preceding with a succeeding activity.
  - c) is common to two or more networks.
  - d) ties together two or more events within a network.

If you had difficulty selecting the right answer, review Chapter 5.

shredout

It is apparent that completion of the PERT Report (Panel K) is largely (but not completely) a matter of copying the data already entered on the network (Panel N).

The letters which identify the columns of Panel K are listed below. Check those letters whose columns you can now fill out from information on the network (Panel N).

A	F	K	P
B	G	L	Q
C	H	M	R
D	I	N	
E	J	O	

Look again at Panel J, in Volume VI, workbook. Since you have coded all the events on the network (see Panel N), the next step in data processing is to transfer the input information to the \_\_\_\_\_.

## Input Form

Panel K is an exhibit of the Input Form, otherwise titled the "Report." The columns that can be completed directly from the network (Panel N) include the Beginning Event Number. List the other columns that can be completed directly from Panel N.

PERT

Ending Event Number

Optimistic Time

Most Likely Time

Pessimistic Time

Event Title

Time Interval Estimates

Columns F and H on the PERT Report are both labeled "\_\_\_\_\_".  
This word refers to the letter of the alphabet that appears after the 9-digit event coding. Describe in your own words what this letter signifies.

## Shredout

level of management interested in an event

---

The varying levels of management, because of their differing interests, will be given different shredouts. A shredout will often include certain events (and their accompanying data) while excluding others. The distribution of selected information to management is the function of the \_\_\_\_\_ code.

shredout

It is apparent that completion of the PERT Report (Panel K) is largely (but not completely) a matter of copying the data already entered on the network (Panel N).

The letters which identify the columns of Panel K are listed below. Check those letters whose columns you can now fill out from information on the network (Panel N).

A	_____	F	_____	K	_____	P	_____
B	_____	G	_____	L	_____	Q	_____
C	_____	H	_____	M	_____	R	_____
D	_____	I	_____	N	_____		
E	_____	J	_____	O	_____		

E, F, G, H, I, J, K, Q should be checked.

---

You have probably determined that a large part of the Input Form (Panel K) is self-explanatory. However, any questions that you have may be answered by turning to the back of the form. The heading on the back is  
" \_\_\_\_\_."

## Instructions

On the side of the Input Form labeled "Instructions," it says that column A refers to the \_\_\_\_\_ Code. Digits \_\_\_\_\_ through \_\_\_\_\_ may be entered in that column.

Transaction Code

1

5

The purpose of the Transaction Code (TC) is to indicate what action is to be taken in processing each line entry and each IBM card based on that line entry. According to the Instructions, a TC of "1" means an \_\_\_\_\_. The front of the Input Form shows that almost all activities are initial entries because they have a "\_\_\_\_\_" in the TC column.

Initial Entry

1

---

The words "Initial Entry" indicate that the activity is a new activity to be added to the System. All new activities will probably have a TC of "\_\_\_\_\_".

According to the Instructions, a TC of "2" refers to a \_\_\_\_\_  
the three time estimates, a TC of "\_\_\_\_\_" Whenever there is to be a change in any one or all of  
"\_\_\_\_\_" will be used.

Revised Time Estimate

2

Are there any revised time estimates for any activities shown on the front of the Input Form? \_\_\_\_\_. Explain why in your own words.

No

There are no "2' s" in the TC column.

\_\_\_\_\_

A TC of "3" is used to change a \_\_\_\_\_ and/ or to add a name for a particular event. This code is also used to give a description and a scheduled date to initial events of a network. Explain why the TC of "3" is used on the top line of the Input Form?

scheduled date

To give a description and scheduled date to the initial event.

\_\_\_\_\_

According to the Instructions, an Activity Completion Date is given a TC of "\_\_\_\_\_. " Does Panel K, the Input Form, show any activity completion dates? \_\_\_\_\_

4

No

Only when an actual date of completion has been achieved will a TC of 4 be assigned. Could there be any TC4's at the very start of a project?  
\_\_\_\_\_ Explain in your own words.

No

Because an actual completion date will not have been achieved; only scheduled completion dates may be known at the start of a project.

A TC of "5" is used to delete an \_\_\_\_\_.



In this diagram, which activities have been deleted and which added?

Deleted

Added

# Activity

## Deleted

1-2

2-3

## Added

1-3

Moving now to the next column (B) on the face of the Input Form, we see that it is labeled "\_\_\_\_\_ Flag." In your instructions, it says, "The digit "\_\_\_\_\_ will be used when the \_\_\_\_\_ is operated."

Short Path

I

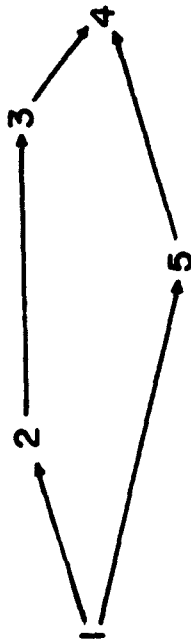
Short Path

The Short Path Flag is used when you have several parallel paths in the network leading to the same event and intend to accept that path which is completed first. The Short Path Flag appears with each of the last activities that terminate in this event.

Another way of saying this is that the expected date for certain events should be selected as the earliest date instead of the \_\_\_\_\_ date from all paths leading to that event.

latest





If paths 1-2, 2-3, 3-4 and 1-5, 5-4 represent two parallel efforts to complete event 4, a Short Path Flag must be included with activities 3-4 and 5-4 to indicate that event 4 will occur at the earliest time possible with either of the two activity paths terminating in event 4. In the "Short Path Flag" column below, insert wherever needed the symbol that tells the computer to select the short path.

Short Path Flag	2

Beginning Event No.	Ending Event No.
E	G
200-100-001	200-100-002
200-100-002	200-100-003
200-100-003	200-100-004
200-100-001	200-100-005
200-100-005	200-100-004

B	
2	

E

200-100-001  
200-100-002  
200-100-003  
200-100-001  
200-100-005

1

1

G

200-100-002  
200-100-003  
200-100-004  
200-100-005  
200-100-004

After Short Path Flag comes column "C", the \_\_\_\_\_ Flag. Both of these columns, according to your instructions, make use of the digit " \_\_\_\_\_ ". In column C, this digit is used to indicate an \_\_\_\_\_ event.

Overlap

1

overlap

---

At present the computer routine used by the Air Force for PERT networks can handle no more than 4,095 events or activities. To process larger networks, a program routine called Modular System is being developed. For the Modular System large networks will be divided into modules, each containing no more than 4,095 events. The Overlap Flag will designate those events that are common to two or more modules in the \_\_\_\_\_ system

## Modular

---

You may have surmised that these "flags" are so called because they are used for "flagging" purposes, thus enabling easier sorting and identification. The next column (D) has a similar purpose, namely to aid in identifying types or groups of \_\_\_\_\_ for easier sorting and rapid identification.

activities

---

According to your instructions, activities are coded with any one of the alphabetical letters, as well as digits \_\_\_\_ - \_\_\_\_ plus 16 standard characters. Of the alphabetical symbols, "F" stands for "Fabrication," "T" for "Testing," and so on. On the front of your Input Form (Panel K) you can see several activities coded with "F." All these different activities are part of the group called "\_\_\_\_." Compare these activities on Panel K with those shown in Panel N where the activity code appears above its activity. Do the activity codes on the two panels agree for the same activity? \_\_\_\_\_. (Yes/No)

0-9

Fabrication

Yes

---

All the activities coded with an "F" could be sorted for a printout, if you so desired. This code is included only as another aid in evaluating a network. It can be left blank throughout the network if it is not found useful.

Most of the remaining columns of Panel K need little explanation. The beginning and ending event numbers both contain \_\_\_\_\_ (how many? ) digits. The shredout code (columns F and H) signifies the level of management interest by means of a \_\_\_\_\_.

9

letter

Columns I, J, and K show the three \_\_\_\_\_ estimates. By looking at these estimates on the front of the Input Form, you can see that each is made up of \_\_\_\_\_ digits. Turning to your instructions, you find that these digits stand for weeks to the nearest \_\_\_\_\_ of a week.

time

4

tenth

\_\_\_\_\_

The data on your Input Form shows that activity 134-210-001A/  
134-210-002D has time estimates, respectively, of 1 week, 3 weeks, and  
\_\_\_\_\_ weeks.

The activity just below that has estimates of \_\_\_\_\_ weeks,  
\_\_\_\_\_ weeks and \_\_\_\_\_ weeks.

The activity just below that one has estimates (use your own words).

6

5, 7, 8

1/10 of a week, 2/10 of a week, and 5/10 of a week

---

Columns L, M, and N refer to the "Scheduled or \_\_\_\_\_." According to your instructions, a total of \_\_\_\_\_ digits must be used for the dates. The very first event in the network, according to the first line on your Input Form, has a scheduled or completion date of July \_\_\_\_\_, 1962. The next date you see is \_\_\_\_\_, 1962.

Completion Date

6

13

June 4

---

A "Scheduled Date" is a date by which the initiators would like a particular event to be completed. The "Completion Date" refers to the actual date of \_\_\_\_\_ of an activity. If, during successive runs of the computer, some activities are known to have been completed, the actual date of \_\_\_\_\_ is accepted as an input.

completion

completion

Column O, according to your instructions, is always left \_\_\_\_\_.  
Column P is the \_\_\_\_\_ code that indicates who is the responsible  
"\_\_\_\_\_". The particular code in this case consists of the letters  
"\_\_\_\_\_" which stand for \_\_\_\_\_.

blank

responsibility

contractor

FMC

Fairweather Missile Corporation

As your instructions indicate, column Q is reserved for the \_\_\_\_\_  
is labeled, \_\_\_\_\_ -- the title of the ending event. The second ending event title \_\_\_\_\_

Event Title

St. Maint. Equip. Fab.

---

Column R of Panel K has two spaces for the last two digits of the  
Code. As you already know, three digits comprise this Code.  
The last of these appears with the event code number.

## System

There are some additional instructions on the back of the Input Form which we will now touch upon. Note that the first paragraph emphasizes that a separate report (Input Form) is to be submitted for each \_\_\_\_\_

Three networks require \_\_\_\_\_ (how many?) Input Forms.

## PERT flow chart

3

Note in the paragraph titled "Submission" that reports will be submitted \_\_\_\_\_. In the same paragraph it says, "Reports are required even though \_\_\_\_\_ occurred during the reporting period. Verbal reports will be accepted under unusual circumstances, but must be confirmed with \_\_\_\_\_ reports."

bi-weekly  
no significant developments  
written

---

The "Scope of Report" instructs you to report on 4 items. These items are:

- 1.
- 2.
- 3.
- 4.

1. New activities
2. Deleted activities
3. Completed activities
4. Any activities for which the estimated completion times require revision.

TEST NO. 1

Circle the letter identifying the phrase which appears to be most nearly correct.

1. The Shredout Code identifies
  - a. time duration.
  - b. level of management interested in an event.
  - c. the overlap flag.
  - d. a particular beginning or ending event.
2. The Transaction Code refers to
  - a. level of management interested in an event.
  - b. the Modular System (when it is used).
  - c. input audit.
  - d. action to be taken in processing each line on the Input Form.
3. When you wish to choose between two parallel paths leading to the same event in a network, you can use the
  - a. Overlap Flag.
  - b. Short Path Flag.
  - c. Transaction Code.
  - d. Modular System.

4. Both beginning and ending event codes contain
  - a. 3 digits.
  - b. 6 digits.
  - c. 9 digits.
  - d. 12 digits.
  
5. A completion date refers to the
  - a. actual date of completion of an activity.
  - b. date you would like a particular event to be completed.
  - c. Scheduled completion date.
  - d. Network ending event only.

If you had difficulty selecting the correct answers, review Chapter 1.

## Chapter 1

### Summary

Completion of the PERT Report is largely (but not completely) a matter of copying the data already entered in the network.

The function of the shredout code is the distribution of selected information to varying management levels.

The back of the PERT Report contains instructions on filling out this form.

The purpose of the Transaction Code is to indicate what action is to be taken in processing each line entry and each IBM card based on that line entry.

The Short Path Flag is used to indicate the earliest completion data of two parallel efforts.

The Overlap Flag will come into use once the Modular System, now planned to handle more than 4,095 activities or events, is developed.

Activities may be coded by function (e.g., Fabrication) to aid in network evaluation.

**PERTeach**  
**Volume V**  
**CHAPTER 2**

**The PERT Job Order Form**

(Keep in mind that the Job Order Form, will vary from one installation to another. The Job Order Form as used at ASD is discussed in this section.)

The Input Form has 80 columns. The PERT Job Order Form also has \_\_\_\_\_ columns. The reason for this is that the input data must eventually be transferred to the 80 column \_\_\_\_\_ cards.

80

IBM

According to Panel J, the data on the Input Form must be analyzed before the \_\_\_\_\_ Form is filled out. The reason for this analysis is simply to make certain that the network and schedule information have been correctly transferred to the Input Form. For this purpose you would compare your input information (network and schedules) with that contained on the \_\_\_\_\_ Form.

Job Order  
Input

---

Panel O shows a sample Job Order Form. As the title of this form suggests, it is used to give information about a job that must be carried out by the computer. This information is put on an Initial IBM card shown at the top of Panel P. As shown on the bottom half of Panel P an Activity Card is required for each \_\_\_\_\_ from AFSC Form 30, the Input Form.

line entry

---

Compare the card layout headings for the initial card with the initial card information on the Job Order Form. Are the data requirements the same or quite different? \_\_\_\_\_.

Look at both the activity card and the Input Form. Do the data requirements match or are they different? \_\_\_\_\_.

same  
match

\_\_\_\_\_

There are, then, two forms with input data, plus their corresponding IBM cards. List the forms and cards:

	<u>Form</u>	<u>Card</u>
1.	_____	_____
2.	_____	_____

<u>Form</u>	<u>Card</u>
1. Input Form	Activity Card } Initial Card }
2. Job Order Form	
	either order

Let's take a closer look at the Job Order Form, even though much of it is self-explanatory.

Near the top of the form you can indicate whether you want "Standard Sorts with Nomenclature" or "Standard Sorts without Nomenclature." On this particular form, Standard Sorts \_\_\_\_\_ Nomenclature have been requested

with

---

"Standard Sorts" refers to "Standard Outputs." The standard outputs shown near the bottom of the Job Order include printouts that are listed in Event Order, Slack Order, and \_\_\_\_\_ Order.

Although we will examine these outputs in more detail later, look for a moment at Panel L. There you see a typical output that is sequenced in \_\_\_\_\_ Order.

Expected Date  
Event

\_\_\_\_\_

Still looking at Panel L, notice that the Expected Date and Latest Date Columns are listed in no particular order. Are the Slack Times listed in sequence? \_\_\_\_\_ The only listing on this output that is in sequence is the column labeled, "\_\_\_\_\_".

No

Event NR.

\_\_\_\_\_

Returning to the Job Order Form, Panel O, you can see that there are 4 types of computer runs listed near the top. These 4 types are:

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

This particular run is of the \_\_\_\_\_ type.

Initial  
Integrated  
Update  
Simulation  
  
Initial

---

On Panel O, the initial card information that is to be keypunched is shown in a series of blocks covering columns 1 through 79.

Columns 10-12 are labeled, "Nr. of \_\_\_\_." In your own words, what does this term refer to?

Column 19 shows the letters " \_\_\_\_." These letters refer to the E-L Graph, a type of output that shows a chronological display of the Expected (E) and Latest (L) times for each \_\_\_\_ in the network.

Mods or Modules: Computer runs, of up to  
4,095 events - the current limit in PERT  
computer processing.

E-L

event

Column 20 is labeled, "\_\_\_\_\_" . " This column is coded to indicate whether the network time estimate is more or less than 7.8 years.

Column 21 refers to "\_\_\_\_\_" - the type of computer output.

Column 22 is labeled, "\_\_\_\_\_" . " This is still another type of output which is also listed on the bottom part of the Job Order Form under "Extra Outputs." In addition to a listing of Activities, these Extra Outputs include \_\_\_\_\_

Yr. or Year

Sort

Activity

Audits, D-E-D, and E-L (more on these later)

By way of summarizing what we have discussed about the Job Order, we have seen how this Form is used to issue specific computation instructions. Data on this form are transferred to an IBM \_\_\_\_\_ for use by the computer.

After the computer has been given instructions, an activity card is made up for each line entry on the \_\_\_\_\_ Form.

card  
Input

---

After all the input data has been transferred to IBM cards, there is carried out what is called an "audit" run. Panel Q shows an list of cards punched from AFSC Form 30, the Input Form. Why do you suppose we have an audit run of all cards before they are inserted into the computer? (Explain in your own words.)

## Audit

---

Compare the keypunched cards with the Input Form to see that the number of cards equals the number of lines or activities on the Input Form. The audit run is also useful in making certain that the card data agree with that on the Input Form.

The audit check serves as another record of the network data and it is very useful in checking out errors of omission. The audit helps to insure the accuracy of the computer inputs and \_\_\_\_\_.

Each row on the audit list is equivalent to its corresponding line entry on Input Form \_\_\_\_\_.

outputs

AFSC30

5-61

TEST NO. 2

Circle the letter identifying the phrase which appears to be most nearly correct.

1. The PERT Job Order Form is
  - a) used after output analysis.
  - b) filled out in exactly the same way for all projects.
  - c) used to give information about a job that must be carried out by the computer.
  - d) filled out before the Input Form.
2. IBM cards are derived from information on
  - a) only the Input Form
  - b) only the Job Order Form
  - c) neither form
  - d) both forms

If you had difficulty selecting the right answers, review Chapter 2.

## Chapter 2

### Summary

The Job Order Form is used to give information about a job that must be carried out by the computer. After this Form is completed, the information on it is transferred to an Initial IBM card.

The data on the Input Form are also transferred to IBM cards - one card for each line entry.

An important use for the Job Order Form is to request printouts in any desired sequence, such as event order, slack order, or expected date order.

**PERTeach**

**Volume V**

**CHAPTER 3**

**PERT Computer Printout Analysis**

**5-64**

Our discussion has so far been centered mainly on the computer inputs. We will now dwell on the outputs of which there are several types. Any one of these types may be obtained, you will recall, by instructions written on the \_\_\_\_\_ Form.

## Job Order

Before proceeding with the analysis, look at Panels R and S for a display of the various types of outputs. Note that only one page of each of 8 printouts is shown. The output shown as Panel R1 is an identification page, with such things as computer problem number, programmer's name, etc.

Panel R2 consists of computer operations instructions. The space between line "5" and "All Data Is In" is the location in which diagnostic aids (discussed later) are recorded for the benefit of the analyst. The phrase "All Data Is In" indicates that all input cards have been read and processed initially.

A quick glance at the various printouts will show you that many contain nearly the same information, but that each is organized in a different way. Panel R3 concerns mainly the activities and the related data. That is why this form is called an                      printout.

activity

---

Panels R and S show three event printouts. Panel R4, for example, is in \_\_\_\_\_ sequence.

This event sort or event sequence printout lists all events in numerical order by event code allowing the user to pick out a particular \_\_\_\_\_ and its related information rapidly.

Suppose you wanted to know which event had to be completed before "missile function testing" could be started. Using the event sequence printout, the number of the event (critical predecessor) here referred to is \_\_\_\_\_.

Turn this page, turn the book around and continue the program on page 5-70.

event

event

134-210-004D

---

Panel S2 is another event printout, but this time the sequence is by order of their expected date of accomplishment. This sort lists events in chronological order of their expected date of accomplishment, so that the manager can quickly see what is to be accomplished during the next month or during any time period of interest.

Suppose you are this manager. Making use of the appropriate computer printout, how many events do you expect will be accomplished during the month of August, 1962? \_\_\_\_\_.

expected date

6

Panel S3 is a third event printout showing a \_\_\_\_\_ sequence.  
This sort is one of the most useful output reports. For example, it quickly identifies the critical path, since the negative slack will be the greatest along this route. Knowing this, how many events fall on the critical path? \_\_\_\_\_

Note also that this printout includes the expected date of accomplishment and latest date by which the event can occur without delaying the program. What is the latest date for delivery of the first operational unit? \_\_\_\_\_

slack

7

16 May 1963

---

The printout shown as Panel S-1 is called the \_\_\_\_\_ Graphic Chart. This is a chronological display of the Expected (E) and Latest (L) times for each event in the network.

Look at this printout. The series of letters (JFMAM, etc.) printed near the top of the form stand for the \_\_\_\_\_ of the year. You can see that a nearly straight, vertical line can be drawn through most of the expected and latest dates. Name the months and the year around which most of these dates cluster. \_\_\_\_\_ and \_\_\_\_\_.

The event shown on the chart that is expected to be completed last is numbered \_\_\_\_\_.

E-L

months

June, July, and August

134-210-010-D

The last printout, Panel S4, contains instructions to the computer operator. The instruction shown reads, \_\_\_\_\_.

Leaving aside the printouts for a moment, let's glance at what output analysis consists of. There are 2 parts to output analysis:

1. Network debugging and determining the reasonableness of the time estimates;
2. Analysis of output data to obtain pertinent information that may be used by various levels of management.

We will concentrate now on the first of these, namely network \_\_\_\_\_ and time estimates.

Save A3 (My Output)  
debugging

---

Central to network debugging are the diagnostic aids which point to the location of errors. These aids are shown on the Instructions printout (Panel R2) between line 5 and "All Data Is In." One error is pointed to in that space. This particular error happens to consist of a schedule date coming before the start date. The instruction shown, therefore, is to \_\_\_\_\_ the schedule date on event 134-210-019.

delete

---

There are many other types of errors which the diagnostic aids will print out in addition to a schedule date coming before a \_\_\_\_\_ date. For example, an actual or schedule day of the month which was greater than "31" would be in error because (Explain in your own words).

start

there are no months with more than 31 days.

\_\_\_\_\_

Could a schedule month be numbered higher than 12? \_\_\_\_\_

The first place to check for these and other errors is the printout of the diagnostic \_\_\_\_\_ (Panel R2).

The Activity Printout (Panel R3) also contains useful data for debugging purposes. For example, if an activity were missing on this printout that is contained on the network, you would assume that a card had not been introduced into the \_\_\_\_\_.

No  
aids  
computer

---

So that you may locate the data associated with specific activities more easily, a brief description of the activity printout (R3) will be given. You are already familiar with the first two columns.

The third column, headed "\_\_\_\_\_", "refers to the immediately preceding event that lies on the most time-consuming path leading to a given event. That is, you know that any event will usually have several predecessors. However, only one of these will be on the most time-consuming path; this event is therefore called the critical \_\_\_\_\_.

The fourth column is headed "Sigma \_\_\_\_\_". If you think that the word "Sigma" is "All Greek to you," you would be right -- since this word stands for a letter in the \_\_\_\_\_ alphabet

Critical Predecessor  
predecessor  
Act  
Greek

\_\_\_\_\_  
"Sigma Act" stands for "standard deviation of the activity." A few  
columns to the right of "Sigma Act" we see a column headed "Sigma  
\_\_\_\_\_" For each activity this column gives the standard deviation of  
the activity ending \_\_\_\_\_.

Event

Event

The column next to the one headed "Sigma Act" is headed TE/AC.  
This column gives the Expected Activity Time, ( $t_e$ ) of the activity, in weeks.  
According to Panel R3 the first activity is expected to require \_\_\_\_\_ weeks.

### 3.2

---

The two columns headed EXPEC TIME and LATES TIME refer to the activity ending event.

The next column on Panel R3 about which you may have a question is titled SC/ AC Time. This column lists the Scheduled Time or Actual Time of each event in weeks as measured from the project start date 13 July 1962. The next three columns all have in their headings the two letters \_\_\_\_\_ which stand for Tally.

TA

\_\_\_\_\_

The column titled "SU TA" means "Successor  
the number of activities leading out from the Ending Event. How many activities  
lead out from the Ending Event of the first activity? \_\_\_\_\_

TALLY

1

---

"SU TA," meaning "\_\_\_\_\_ " is to be contrasted with the column titled "PD TA," meaning "PreDecessor Tally." Since "SU TA" stands for the number of activities leading out from the Ending Event, what do you suppose "PD TA" (PreDecessor Tally) means?

SUccessor TALLY

PD TA: the number of activities leading into the Ending Event.

\_\_\_\_\_

"AD TA" stands for Actual Date TALLY, and refers to the number of these ending events which have been given actual \_\_\_\_\_.

Try to answer this now: Would you pay more attention to a 3 in the "SU TA" column, than you would to a 1? \_\_\_\_\_ Explain your answer.

dates

Yes

Because an activity with a SU TA of 3 would have three activities leading out from the Ending Event and would thus be more critical than an activity with a SU TA of only 1.

---

Several of the remaining columns have already been discussed in another context. "OF" signifies "Overlap". When this procedure comes into use it will refer to those larger networks with more than 4,095 events or activities and which are, therefore, broken up into two or more modules. The Overlap Flag is used to identify the Ending Event that is a connector between such modules.

## Flag

---

The next column ("SP") stands for "Short Path Flag." By way of review, what does this Short Path technique accomplish?

"TC", as you know, refers to \_\_\_\_\_. The explanation of TC is briefly contained on the back of the \_\_\_\_\_ Form, AFSC 30.

SP: When several parallel efforts are being pursued to insure a solution to the objective represented by the common ending event of the parallel paths, the SP Flag permits selection of that activity path that reaches the event first. Note however, that this technique applies to events within the network -- not to the network ending event.

TC: Transaction Code  
Input

The column titled "AC" lists the Activity Code. The most frequently appearing Activity Code is " \_\_\_\_\_ " which, as you may recall, identifies "Fabrication."

## F

### Fabrication

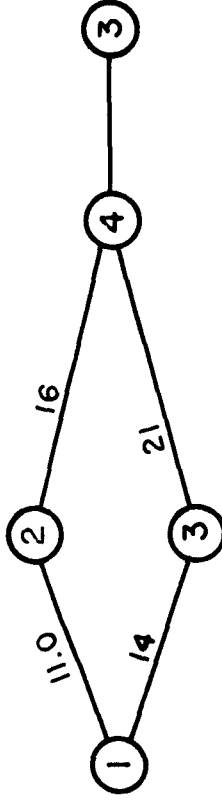
---

The next column, titled "AF", lists an "A" when activities have been reported complete.

The "Rank Tal" column lists the Rank Tally of the activity. The rank of an activity equals the maximum number of activities that precede this activity on any single path, from the beginning of the network. The highest Rank Tally shown is \_\_\_\_\_.



The Slack column lists the slack for the Activity on this line. Activity Slack can best be explained by an example:



By activity path 1-2-4, the  $T_E$  of event 4 is 27 (11 + 16).  
 By activity path 1-3-4, the  $T_E$  of event 4 is 35 (14 + 21).

The difference between these two  $T_E$  values (8) represents the activity slack of activity 2-4, that is, activity 2-4 can be completed in 16 + 8 weeks or 24 weeks without delaying the occurrence of event 4 at a  $T_E$  of 35 weeks as required by activity path 1-3-4. In that case, activity path 1-2-4 would take 11 + (16 + 8) weeks = 35 weeks. Activity slack can be applied to each of several activities, all of which have a common ending event.

When we are concerned with a complete network, rather than the activities flowing to a common ending event within the network, we determine Event Slack ( $T_L - T_E$ ). Each event has only one event slack value, although it may be associated with more than one activity slack value.

Turn now to Panel S3. The main column of interest here is that headed  
\_\_\_\_\_ Time. Does this column have figures listed in a  
definite order? \_\_\_\_\_.

Slack

Yes

\_\_\_\_\_

The most important information you can get from the Slack Time listing is the knowledge of which events fall on the \_\_\_\_\_ path. On Panel S3, this path is made up of those events with -17.0 weeks slack time. The next critical path after this one consists of those events with \_\_\_\_\_ weeks slack. Note that the critical paths show that the expected dates are often much \_\_\_\_\_ (earlier/later) than the latest dates.

critical

10.7

later

\_\_\_\_\_

The next column after "Slack Time" on Panel S-3 is labeled, " \_\_\_\_\_ " which was called "Sigma" on the Activity Printout. This column lists the Standard Deviation for the event specified under Event No. Standard Deviation is a measure of uncertainty associated with that event. The larger the standard deviation, the greater the uncertainty. Which two events have the greatest uncertainty?

Event No. \_\_\_\_\_

Event No. \_\_\_\_\_

Std. Dev. (Standard Deviation)

134-210-028B

134-210-029A

---

After "Std. Dev." comes " \_\_\_\_\_ " which stands for Probability. When figures are shown in this column, you will have a quantitative estimate of how likely or probable it is that the scheduled date will be met for a particular event. The one probability figure shown is \_\_\_\_\_ which indicates that there is very little or no \_\_\_\_\_ of meeting the Scheduled Date of the ending event.

Prob.

0.00

probability

---

In what ways can you check on the reasonableness of the network and time estimates? The amount of slack time is the first indication of the reasonableness of the network and \_\_\_\_\_. If, for example, there is too much positive slack, it may be that the time estimates are overly optimistic. If - and this occurs much more often - there is excessive negative slack, it may be that the time estimates are too \_\_\_\_\_.

time estimates  
pessimistic

---

Don't be alarmed by negative slack; it means only that the final event in most cases (will/won't) be completed on the scheduled date with the existing plan. In order to meet the final scheduled date, you would have to create a new \_\_\_\_\_.

won't

plan

---

So much for the interpretation of negative slack. Let's talk a bit more about Standard Deviation and Probability - two very important aspects of PERT. You will agree, if PERT is to be a good management tool, it (like any tool) must be properly used. To concentrate on the calculated times without taking into account the probability or chance that they will be met, is like betting on just any horse in a race.

The shrewd bettor - be it in a horse race, a ball game or PERT - takes into account the chance aspects involved. The Standard Deviation is a measure of chance. The lower the Standard Deviation, the higher the or probability that the event will occur as expected. High Standard Deviations, on the other hand, represent areas of great risk and you would, therefore, take steps to reduce the involved.

chance

risk

---

Generally speaking, when the probability-of-success figure lies below 0.25 (or 25%), considerable risk is associated with the program. Probabilities between 0.25 and 0.60 are more normal. The greater the probability figure, the more certain we are that the project will be completed on schedule. However, to obtain a probability much greater than about 0.60, it may be necessary to commit excessive amounts of resources to the project.

One way of thinking about a PERT network is to consider it as a whole series of bets. For example, the Event Expected Time ( $T_E$ ) has a 50% (or .5) probability of being achieved. If an event has a 50% chance of being achieved by its  $T_E$  time, then the probability of achieving this event before its  $T_E$  time is \_\_\_\_\_ (greater/less) than 50%, and the probability of achieving this event after its  $T_E$  time is \_\_\_\_\_ (greater/less) than 50%.

less

greater

---

What action might you take if you found low probability figures on the critical path? You might, for example, want to allow for overtime and additional personnel. By thus increasing your resources, you would be acting to increase the probability that the events in the critical path will be completed on time. One result of this might be that the critical path will no longer be \_\_\_\_\_.

critical

---

By eliminating the path which was critical, you will have created a new critical path. Look at Panel S3. The probability of meeting the scheduled date on the critical path is \_\_\_\_\_. By increasing your resources on the events in this path, you may permit another path to become the critical one. In the Panel, such a new path would consist of those events with a slack time of \_\_\_\_\_. You may also find that slack time of this path may be reduced by the reduction in slack on the original critical path.

0.00

-10.7

5-103

TEST NO. 3

Circle the letter identifying the phrase which appears to be most nearly correct.

1. The location of printout errors is facilitated most by the
  - a. Activity Printout.
  - b. Event Printouts.
  - c. Slack Order Printout.
  - d. Diagnostic Aids.
2. The Critical Predecessor refers to
  - a. an immediately succeeding event.
  - b. the critical path.
  - c. an immediately preceding event.
  - d. the immediately preceding event that lies on the path of least slack leading to a given event.
3. A measure of uncertainty used in PERT is the
  - a. Activity Time.
  - b. Standard Deviation.
  - c. Predecessor Tally.
  - d. SC/AC Time.

4. Activities with several events leading into and out of them are
  - a. of little importance in output analysis.
  - b. the only type of activities dealt with in output analysis.
  - c. known as Critical Predecessors.
  - d. important in output analysis.
5. The knowledge of which activities lie on the critical path is most quickly obtained from the
  - a. Event Printout - Slack Sequence.
  - b. Activity Printout.
  - c. Event Printout - Event Sequence.
  - d. Event Printout - Expected Date

If you had difficulty selecting the right answers, review Chapter 3.

## Chapter 3

### Summary

Many computer printouts contain the same information, but each is organized in a different way.

The activity printout is organized around the sequence of activities while the event printouts may be ordered in event sequence, expected date or slack sequence. The latter printout is one of the most useful because it permits quick identification of the critical path.

The E-L Graphic Chart is a chronological display of the Expected (E) and Latest (L) times for each event in the network.

Output analysis is a twofold process that consists of:

- (1) Network debugging and determining the reasonableness of the time estimates;
- (2) Analysis of output data to obtain pertinent information that may be used by various levels of management.

Important in PERT is the standard deviation, which is a measure of uncertainty concerning the chances that an event will or will not occur.

PER Teach

Volume V

CHAPTER 4

Updating the Network and Simulation

Now we want to talk about an important treatment of PERT inputs -  
updating.

PERT is a dynamic system in that it can incorporate the many new facts and changes that inevitably take place once a project begins.

Updating networks introduces new facts, conclusions, and re-direction of effort.

Examples of the input entries required for an update are shown in Panels T and U which are, respectively, the \_\_\_\_\_ Form and the \_\_\_\_\_ Form.

Of course, before either of these forms may be completed the network must be updated. Any alteration of network characteristics, such as addition or deletion of events, or changes in time estimates, requires updating of the network. Turn now to Panel V which shows and updated \_\_\_\_\_.

(PERT) Job Order

Input (AFSC 30)

network

---

The notes on the lower right portion of Panel V give a clue concerning some of the changes that have been made in the network. Note, for example, how a deletion is made. Which activity appearing in the network shows signs of being deleted? \_\_\_\_\_.

Note also the manner in which a completed event is indicated. Which network event was completed earliest? \_\_\_\_\_.

134-210-027/ 134-210-029A

134-210-001A (Initial Event)

\_\_\_\_\_

Notice how the revised time estimates are shown on the updated network.  
The original estimates are crossed out. Where are the new ones placed?

\_\_\_\_\_.

After the network is updated in this fashion, the Job Order must be  
completed. Look at Panel T. What type of run is designated on this Form?

\_\_\_\_\_.

## activities

---

According to your instructions, activities are coded with any one of the alphabetical letters, as well as digits \_\_\_\_\_ - \_\_\_\_\_ plus 16 standard characters. Of the alphabetical symbols, "F" stands for "Fabrication," "T" for "Testing," and so on. On the front of your Input Form (Panel K) you can see several activities coded with "F." All these different activities are part of the group called "\_\_\_\_\_." Compare these activities on Panel K with those shown in Panel N where the activity code appears above its activity. Do the activity codes on the two panels agree for the same activity? \_\_\_\_\_. (Yes/No)

deletion of an activity

An especially important feature of the updating process is the close attention paid to the critical path. It is highly desirable to examine and, if necessary, re-estimate some of the activity times along the \_\_\_\_\_ (slack/critical) path.

critical

---

There are at least 2 good reasons for updating the estimates on the \_\_\_\_\_ path:

1. Tight areas of the program are highlighted.
2. Estimates in these areas are marked for critical analysis with an effort to produce more accurate data.

The critical path should be frequently up \_\_\_\_\_.

critical

updated

---

In many instances, updates are supported with written analyses. Such analyses will often include comment on:

1. causes contributing to delay,
2. forecast effect of delay,
3. validation for network changes,
4. action contemplated,
5. action taken,
6. results of action taken,
7. recommendations,
8. outlook.

While updates represent commitments and actual changes, simulations are replanning exercises which help to determine what would happen if such and such were changed. Simulations \_\_\_\_\_ (always/ never) represent commitments or actual changes.

never

---

Do you see the usefulness of simulations? All kinds of possibilities can be explored on a tentative basis. The decision-making process is thereby immeasurably improved. Simulations are submitted in the same manner as original network reports and updates. The simulations can be made manually or on the \_\_\_\_\_.

computer

5-119

TEST NO. 4

Circle the letter identifying the phrase which appears to be most nearly correct.

1. Incorporating new facts and changes into a network is called the
  - a. Integration Technique.
  - b. Simulation Process
  - c. Updating Procedure.
  - d. Network Debugging Procedure.
2. Simulations are
  - a. the same as updating procedures.
  - b. replanning exercises.
  - c. actual changes and commitments.
  - d. unrelated to decision-making.

If you had difficulty selecting the right answer, review Chapter 4.

## Chapter 4

### Summary

The changes that inevitably occur once a project begins may be incorporated by means of the procedure called "updating" network. This updating introduces new facts, conclusions, and re-direction of effort.

The Job Order Form and PERT Report must be properly completed for updating after the network has been revised.

Close attention is paid during updating to the critical path activity times, should re-estimation of these be necessary.

While updates represent commitments and actual changes, simulations are replanning exercises which help to determine what would happen if such and such were changed.

PERTeach

Volume V

CHAPTER, 5

Integration of Networks

As you know, the PERT network serves, among other things, to show the impact of one event upon another. Event B, for example, cannot be started until the completion of event A, etc. But what of large, complex programs that require several networks? Just as events affect each other within a single network, they also may affect other events in other networks.

The object of this section is to show you how to answer this question:  
"What is the impact of events upon each other when they occur in different networks of the same overall program?"

Interrelating the events in different networks is made possible by the network integration technique.

Although it is possible to determine on a manual basis the effects of events in separate networks on each other, it is far more efficient to allow the \_\_\_\_\_ to work out the various impacts.

The first and major step in the integration technique is to find an event that is common to each network. Such a common, or interconnecting, event is best known as an interface \_\_\_\_\_.

computer

event

---

Look at Panel W. Reading from top to bottom, we see 3 "start" events: Guidance, Airframe, and \_\_\_\_\_. How many networks does this Chart Contain? \_\_\_\_\_

Re-entry

3

---

The three networks, although shown separately on Panel W, are actually interrelated because they have several events in common. Such events, best known as \_\_\_\_\_ events, are highlighted by the double-line enclosure. An example of one such event is 700-002-003B. This event appears in both network B and network \_\_\_\_\_.

interface

C

---

The integration of the three separate networks is shown in Panel X. The interface events now appear only once and serve to unify the networks.

Returning to Panel W for a moment, you will note that each network has its own critical path -- as shown by the double lines. The critical path for the Panel X integrated network, however, starts in the Guidance Network, drops to the \_\_\_\_\_ Network, and then moves to the \_\_\_\_\_ Network.

Re-entry

Airframe

---

As you might expect, the printout of the integrated networks differs in many respects from the printout that would be obtained if the networks were not integrated. One implication of this is that although the individual network plans may have been satisfactory, once they are integrated, scheduling of one network may affect the others so much that new plans are made necessary.

An example of how the integrated network differs considerably from the independently run networks is the following: When the Airframe network was run independently, the Expected Date for event 700-002-051A, the final event, was 18 July 1962. This same event on the integrated network printout (see Panel Y) now has an Expected Date of \_\_\_\_\_.

Guidance and Re-entry (other two)

---

We have seen how the individual plans may be satisfactory, but when tied together, the scheduling of one affects the other considerably.

Note that the probabilities in the integrated network printout (Panel Y) vary from \_\_\_\_\_ to \_\_\_\_\_. The large number of low probabilities suggest what sort of action by the program manager? (Explain in your own words.)

0. 60

1. 00

There must be either a radical change in plan  
or new allocation of resources.

TEST NO. 5

Circle the letter identifying the phrase which appears to be most nearly correct.

1. The Integration Technique allows you to evaluate
  - a) the impact of events in different networks upon each other.
  - b) the relationships between events in the same network.
  - c) the impact of new facts on the progress of the critical path.
  - d) the relationships between the old critical path and the new one.
2. An Interface Event
  - a) connects one activity to another.
  - b) connects a preceding with a succeeding activity.
  - c) is common to two or more networks.
  - d) ties together two or more events within a network.

If you had difficulty selecting the right answer, review Chapter 5.

## Chapter 5

### Summary

Interrelating the events in different networks of the same over-all program, in order to show the impact of events upon each other, is made possible by the network integration technique. The first and major step in this technique is the location of interface events - those common to each network.

Although individual network plans may be satisfactory, once they are integrated, scheduling of one network may affect the others so much that new plans are made necessary.

This the final page of PERT Network Development and Computer Processing, Volume V of PERTeach. You have now completed the course. We hope you enjoyed taking it and that the knowledge you have gained will be useful to you.